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ABSTRACT

Because the Navy may be forced to use larger numbers of marginally qualified recruits in the future and thus may have to expand its academic remedial training (ART) program, a study was conducted to compare the instructional and cost effectiveness of the standard classroom approach to ART with the use of a computer assisted instructional (CAI) system known as the Performance-related Enabling Skills Training (PREST) program. PREST, which focuses on improving functional reading and study skills, was used with a Control Data Corporation (CDC) PLATO computer system. A total of 152 recruits at Orlando, Florida, participated in the evaluation, with 75 receiving ART through classroom instruction and 77 through PREST. It was found that: (1) the two groups were equal in instructional benefits in terms of immediate and prolonged improvement; (2) the PREST configuration was less cost effective than the classroom approach in 1980; and (3) if civilian instructors were used and computer usage charges declined by 5% per year, PREST would become cost effective in Orlando in the late 1980's. It is recommended that the PREST program not be substituted for the current ART classroom approach, but that consideration be given to replacing the vocabulary and comprehension ART modules with a computer-based system using low-cost stand-alone microcomputers as the delivery devices. These and other recommendations, study methodology and results, and a 20-item bibliography are included. (ESR)

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COMPUTER-BASED APPROACH TO THE NAVY'S ACADEMIC REMEDIAL TRAINING, PROJECT PREST: A COST-EFFECTIVENESS EVALUATION

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FOREWORD

This project was conducted in response to a Chief of Naval Education and Training (N-5) request to evaluate the performance-related enabling skills training (PREST) project, a computer-based approach to the Navy's academic remedial training (ART) program. The evaluation was conducted at the Recruit Training Command (RTC), Orlando, FL during FY80. Results are intended for use by the Chief of Naval Education and Training (N-5) and the RTCs.

We gratefully acknowledge the assistance of CDR James Kiefer, YN2 Pam Keskeys, and the other members of the Academic Remedial Training Division, RTC Orlando; Dr. Ron Bucknam of the National Institute of Education; Nancy Ashcroft of the Orange County (Florida) Board of Public Instruction; Joe Small and Dick Wall of Control Data Corporation; and Joanne Stolte, Shirley Smith, and Keith Kershner of Research for Better Schools, Inc.

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SUMMARY

Problem and Background

The Navy may be forced to use larger numbers of marginally qualified recruits in the future, because of manpower shortages. If this occurs, academic remedial training (ART) will have to be expanded, resulting in a greater number of instructors. Automated instruction is an attractive alternative, since its use can reduce the number of instructors needed. Therefore, to determine the economic and technological feasibility of automated instruction for the ART program, the Chief of Naval Education and Training (N-5) contracted for the development and test of a computer-based approach, hereafter referred to as the Performance-related Enabling Skills Training (PREST) Program.

Objective

The objectives of this effort were to compare the instructional effectiveness of the PREST configuration with that of the standard classroom approach, quantify the differences in effectiveness in terms of cost savings, chart the expected future costs of each alternative as a function of time, and predict the point at which the alternatives break even.

Approach

A total of 152 recruits who were enrolled in the ART program at the Recruit Training Command at Orlando participated in the evaluation. Of these, 75, the control group, received ART through classroom instruction; and 77, the experimental group, through PREST. Because of a change in policy that applied during 2 months, when only PREST recruits were being tested, the overall entering reading grade level (RGL) average of these recruits was one-half grade higher than that of the classroom group. To compensate for this difference, analyses were conducted on test scores obtained by restricted samples, which included only those recruits with RGLs between 5.0 and 6.0. Also, for both groups, restricted and overall samples were compared on background measures, as well as on measures of immediate (during ART) and prolonged (during the 7-week recruit training period) effects of instruction types on Navy-related and general reading skills.

Findings

The two groups were equal in instructional benefits on immediate impact and on prolonged benefits. The cost analysis revealed that the PREST configuration was less cost-effective than the classroom approach in 1980, but that the difference would steadily decline in future years. The predicted point at which the alternatives break even depends on whether the instructors are military or civilian, and on whether the computer usage charge is predicted to remain constant or decline five percent per year. If civilian instructors are used and the computer usage charge declines by five percent per year, PREST will become cost-effective in Orlando in the late 1980s.

Conclusions

Although PREST is not now as cost-effective as the classroom approach to ART, it may become cost-effective in the future. Its cost-effectiveness can be influenced by advances in computer technology (e.g., the continued development of stand-alone systems), the type of instructor used (i.e., military vs. civilian), and the relative costs (e.g., salaries, overhead costs) incurred for these instructors.

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Recommendations

1. The PREST program should not be substituted for the current ART classroom approach at this time.

2. Consideration should be given to (a) replacing the vocabulary and comprehension modules of ART with a computer-based system, and (b) using low-cost, stand-alone microcomputers as the delivery devices.

3. The worksheets currently used with PREST should be incorporated into the ART study skills module.

4. The Navy Recruit Reading Test should be developed further as a selection device for ART.

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INTRODUCTION

Problem

The military prime enlistment pool (i.e., male high school graduates, aged 18 to 21 years, in the higher mental categories) will decrease significantly during the next 20 years (Congressional Budget Office, 1977). Consequently, the military services may be forced to accept more recruits from the lower mental categories. Past experience has demonstrated that these personnel have lower reading abilities, are less useful in the service, and attrite more frequently than do personnel in the higher mental categories.

The Navy currently accepts small numbers of marginally qualified recruits and uses uniformed instructors to teach them basic skills, primarily reading, as part of the academic remedial training (ART) program at the three Navy Recruit Training Commands (RTCs) (Orlando, FL, Great Lakes, IL, San Diego, CA). The purpose of ART is to improve a recruit's reading and study skills so that the recruit can successfully complete the academic portion of recruit training. There is a strong relationship between reading ability and success in military training. For example, Hoiberg, Hysham, and Berry (1974), found that the exit reading grade level (RGL) of ART graduates was the best predictor of successful completion of their first year of Navy service.

If manpower shortages force a lowering of enlistment standards, remedial programs like ART can be expanded to accommodate larger numbers of poorly qualified recruits. Doing so, however, will divert more instructors from their regular assignments. If the Navy must accept increasing numbers of less qualified enlistees and continue enrolling them in the ART program, alternatives to the use of military instructors, such as civilianization or automation, must be considered. At present, civilian ART instructors are used, to a limited extent, at no cost to the Navy through local adult education programs. These arrangements, however, are subject to change owing to policy changes at the local level. Thus, automated instruction appears to be an attractive alternative to the standard classroom approach, with either civilian or military instructors.

Background

ART Program

The current ART program was standardized and implemented in October 1978 and appears to be successful, with over 85 percent of its graduates successfully completing recruit training. The 1979 throughput was 3266 students, with over 10 percent being nonnative English speakers.

The ART program is based on a diagnostic-prescriptive approach to remedial reading and is offered to recruits who score between the 4.0 and 6.0 RGL on the Gates-MacGinitie Reading Test (1978), Level D, which is administered to all Navy recruits during their first week in training. Those scoring above 6.0 continue with recruit training and those scoring below 6.0 are given an alternate version of the test to confirm their initial low score. If recruits score below 4.0 on the second test, they are referred to a Review Board. If they score between 4.0 and 6.0, they are enrolled in ART.

The ART entrants are given the Stanford Diagnostic Reading Test (SDRT), Brown Level (Karlsen, Madden, & Gardner, 1976), which diagnoses weaknesses in vocabulary, literal comprehension, inferential comprehension, phonetic analysis, and structural analysis. Instructional modules in each of these reading skill areas, which were developed by the Memphis State University under contract from the Chief of Naval Education and

Training (CNET), are then assigned to ART entrants according to their diagnosed needs. A separate class is available for each reading skill area, and recruits must pass a criterion-referenced module test before they proceed to the next class. A typical class size is about 12 students per instructor. Recruits require from 1 to 5 weeks to complete the reading skill modules, depending on the number assigned.

After ART recruits complete their assigned reading skills modules, they must complete a study skills module, which prepares them for the academic curriculum of recruit training. (Continued failure in these academic tests can lead to discharge.) This study skills module is also required of recruits who were not selected for ART initially, but who failed one or more academic tests given as part of recruit training.

The confirmatory Gates-MacGinitie and diagnostic tests are administered by an ART staff member and the criterion tests, by the instructors. All tests, from the initial Gates-MacGinitie to the criterion-referenced module tests, are graded with an optical scanner linked to the Navy's Integrated Training and Resource Administration System in Millington, TN. Test administration and grading require one full-time staff member.

Performance-related Enabling Skills Training (PREST) Program

With costs of computer hardware decreasing at a steady pace, prospects for less expensive, computer-based instruction are improving (Wolfe & Williams, 1979). To examine these prospects, CNET contracted for the development of a computer-based ART program that focused on improving Navy functional reading and study skills. The program developed entitled "performance-related enabling skills training" (PREST), called for on-line reading and study skills instruction via the Control Data Corporation (CDC) PLATO system, augmented by Navy-related off-line drill and practice.

PLATO is a comprehensive, computer-based educational system that uses a centralized-mainframe CDC CYBER 70, 170, or 6000 series computer. From this computer, instruction is downloaded over leased phone lines to the PLATO terminal, a microprocessor-based device with 16K of random-access memory available for storage. A read-only memory of 2K bytes contains the operating system and diagnostic routines for hardware maintenance. The terminal provides high-resolution computer graphics, an electronic keyboard, and a touch-sensitive panel.

The on-line portion of PREST consists of two introductory modules, 94 reading modules (selected from among the 111 reading modules within the Basic Skills Learning System, an adult basic skills curriculum from CDC's existing courseware library), and six specially developed study skills modules applicable to academic needs during Navy recruit training. The computer-based management system of PREST routes each recruit through on-line instruction for all of the introductory and study skills modules. For on-line reading instruction, it prescribes and automatically assigns modules based on individual on-line diagnosis.

Off-line study skill application activities allow recruits to make a transition from learning via a computer to learning via reading assignments and classroom lectures, which is the learning mode used in recruit academic training. Supplemental off-line reading drill and practice materials, including those provided with the Basic Skills Learning system and those specially developed for PREST, are available to recruits who wish additional practice or who are waiting for terminal access to continue on-line reading activities.

PREST was designed for use by one military instructor working with 24 recruits having access to 12 PLATO terminals. The instructor's role is to answer recruit questions about the purpose of ART and the operation of the terminals, clarify misunderstandings about what occurs on-line, monitor student progress, provide on-the-spot instruction as needed, direct selected study skills application activities, and provide feedback on some off-line materials.

The instructional objective of both PREST and the standard classroom approach to ART is to provide recruits with basic reading and study skills needed to complete successfully the academic portion of recruit training. Thus, it is important to determine whether PREST is effective, in terms of both instruction and cost, as compared to the classroom approach to ART.

Purpose

The purposes of the evaluation reported here were to compare the instructional effectiveness of PREST with that of the standard classroom approach to ART, quantify differences between the alternatives in effectiveness in terms of cost savings, chart the expected future costs of each alternative as a function of time, and predict the point at which the alternatives break even.

APPROACH

Instructional Effectiveness

Previous CAI cost-effectiveness evaluations have been criticized because they did not objectively monitor students in their follow-on duty assignments (Orlansky & String, 1979). The studies reviewed by Orlansky and String relied on pre-post measures of student performance during training, instructional time, academic attrition, and student and instructor attitudes. Although such measures are critical to assessing a program's instructional effectiveness, they do not address the more important operational issue of job preparedness. Also, postgraduate effectiveness measures often consist only of a supervisor's opinion, which can be influenced by factors unrelated to the training being evaluated.

Because of these criticisms, the current evaluation was designed to compare both the immediate (during ART) and prolonged (during the 7-week recruit training period) effects of classroom and PREST instruction on Navy-related and general reading skills.

Sample

A total of 152 recruits who were enrolled in the ART program at RTC Orlando participated in the evaluation. Of these, 75, the control group, received ART through classroom instruction; and 77, the experimental group, through PREST. All subjects were native English speakers.

Because the number of recruits entering ART Orlando in late 1979 was less than expected, 55 control recruits were tested between October 1979 and January 1980, and the other 20, in June and July, 1980. The entire PREST group was tested between February and May, 1980. In March and April 1980, when only PREST recruits were being tested, a temporary change in Navy policy increased the RGL cutoff score for ART selection from 6.0 to 6.7. This change permitted 21 recruits with RGLs in that range to enter the PREST group, which, meant, of course, that the overall entering RGL average

of PREST recruits was higher than that of the classroom group. Further, the classroom group included more recruits reading below the 5.0 RGL than did the PREST group. Therefore, statistical analyses were conducted on a restricted sample, which included only those recruits with RGLs between 5.0 and 6.0 (47 recruits for both the classroom and PREST groups).

Measures

The following background data were collected for each sample member: (1) the scores obtained on the Armed Forces Qualifying Test (AQFT) and on the word knowledge (WK) subtest of the Armed Services Vocational Aptitude Battery (ASVAB), (2) entering RGL as measured by the confirmatory Gates-MacGinitie test (1978), and (3) high school graduation status.

To measure improvements in Navy-related reading skills during ART, NAVPERS-RANDCEN developed two equivalent 30-item forms of a Navy Recruit Reading Test (NRRT). The test items, which were mainly multiple-choice with an occasional sentence completion item, were patterned after those in the four recruit academic tests that are administered during recruit training. For each version of the test, 10 questions were designed to test recruits' ability to obtain information from the table of contents and index of the Blue Jackets Manual; and the other 20, to comprehend material in three passages on military subjects.[1] Both forms had been pilot-tested at RTC, San Diego. Based on the results of this test, a time limit of 23 minutes was judged as appropriate.

The comprehension section of the two 1965 versions of the Gates-MacGinitie Reading Test was also used to measure improvement in general reading comprehension skills during ART. Since ART students complete one of the two 1978 versions of this test during the first week of training and the other to confirm their initial low score, using them for a posttest would have required administering one form a second time.

The final measure of immediate improvement was the number of instructional days recruits in the control and experimental groups spent in ART. Allowances were made for times when recruits were under medical care or otherwise absent from the classroom. If applicable, reasons for discharge were recorded.

The four recruit academic tests administered during recruit training were used to measure prolonged effects of the two forms of ART. Since the expressed purpose of ART is to enhance performance on the academic portion of recruit training, these tests were the best available measure of ART's effectiveness. The first three tests each contained 50 items; and the final test, 150 items.

Design and Procedure

The design conformed to Campbell and Stanley's "Nonequivalent Control Group Design" (1966); that is, recruits were assigned to one group or the other, depending on the month when they entered the Navy. All subjects entering the ART program were administered one version of the NRRT and Form 1 from the 1965 Gates-MacGinitie test. When they completed the program, they were administered the alternate version of the

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[1]Six passages from the Blue Jackets Manual or The Basic Military Requirements manual were modified by shortening sentences and substituting easy words for difficult words. Three of these passages were included in one test version; and the other three, in the other.

NRRT and Form 2 of the Gates-MacGinitie test. The alternate NRRT forms were counterbalanced between pre-and posttests within each group. During recruit training, the raw scores they obtained on the four academic tests were recorded. If applicable, reasons for discharge were recorded.

Analyses

In both groups, restricted (5.0 to 6.0 RGL) and overall samples were compared on background measures, as well as on measures of immediate and prolonged effects. Also, for the restricted samples, analyses of variance (ANOVAs) were used to compare pre-and posttreatment NRRT and Gates-MacGinitie test scores, as well as the number of instructional days required. The scores obtained by the restricted samples on the four recruit academic tests were compared using a 2 x 4 repeated measures ANOVA.

Cost Effectiveness

The costs of the classroom and PREST approaches to ART, computed in constant 1980 dollars, were compared. For the classroom approach, it was determined that four instructors would be needed, based on a 1979 throughput in Orlando of 929 recruits. This computation assumed an average instructor-to-student ratio of 12, 12.5 days of ART instruction for the average recruit, 250 days per year available for instruction, and a fixed, month-by-month flow of students through ART. (In reality, the throughput is far greater during the summer months. This problem is addressed in the Discussion section below.) One additional staff member would be required to administer and grade the diagnostic test required by the classroom approach, for a total of five military instructors. The cost for these instructors was computed using the billet costs for the typical ART instructor, an E-4 Yeoman ($14,588) (see Koehler, 1980). The costs for ART classroom materials (e.g., the Basic Specific Skills Series, dictionaries, Skim-and-Scan booklets, vocabulary books, etc.) were obtained from supply records. These materials usually can be recycled for use by other recruits; the length of their usable life varies from 1 to about 4 years, for a cost of $2188.

For PREST, costs were based on the utilization of 24 terminals and 2 instructors, since it was determined that these resources could handle a load equivalent to that projected for the classroom approach. The PREST-related expenses include those for the terminals, computer usage charges, hardware maintenance, and instructors. The costs for the terminals were based on a purchase plan, which, in the long run, is far more favorable than a lease option, and were allocated over a 5-year economic life, which is considered a reasonable estimate of the physical/technological life of a terminal. The cost of computer hardware has demonstrated a steady decline, which is predicted to continue (Noyce, 1977). According to the cost figures supplied by CDC, the cost of PLATO terminals has been decreasing about 10 percent per year. This decline was considered in the analysis.

The costs for computer usage, which are tied to system operator and maintenance costs and profit motives are more difficult to predict. Two assumptions can be considered here: either the cost will remain constant, or it will decline at 5 percent per year.

The expenditures that are common to both the classroom and PREST approaches (e.g., for classroom space, desks, overhead lights, etc.) were not included in the cost analysis. Further, costs for ART personnel, such as the division officer and a yeoman, were not included since these personnel would be needed regardless of the instructional delivery used. A workbook by the Training Analysis and Evaluation Group, entitled Improving Your Navy Reading Skills, is used in each approach. Also, the costs of the

consumable test-answer sheets used for the diagnostic and criterion tests in the classroom approach (estimated at $300 per year) are approximately equal to the costs for reproducing sufficient numbers of the consummable, RBS-developed worksheets for PREST. The costs of developing the ART classroom curriculum and the specially-developed PREST materials were treated as "sunk costs."

PREST does avoid the cost of the half day required to administer the diagnostic test and assign an instructional program. PREST does this task on-line at the beginning of the Basic Skills Learning System curriculum. This amounts to a cost avoidance of $7022, which was computed by multiplying the yearly throughput by a recruit's half-day salary.

The cost-effectiveness analysis was based on a break-even analysis, an analytical technique used to study the relationship between alternate cost patterns (Fabrycky & Thuesen, 1974). This analysis focuses on finding the value of a variable, time in this case, at which the economic desirability of two alternatives is equal. Costs for the classroom and PREST versions of ART were projected over a 10-year planning horizon.

Since consideration is being given to civilianizing the program, cost estimates for civilian instructors were obtained from the Orange County (Florida) Board of Public Instruction, Adult Program, which currently supplies ART Orlando with 3.5 civilian classroom instructors at no cost to the Navy. The annual cost for civilian instructors, including overhead, is $21,175. Using this figure to replace the military costs and the previously mentioned assumptions about usage charges, costs for the two approaches were projected thorugh 1989.

RESULTS

Instructional Effectiveness

The mean measures obtained for the classroom and PREST groups are presented in Table 1. As shown, the mean entering RGL, which was based on the confirmatory Gates-MacGinitie test, is one-half grade higher for the total PREST group than for the total classroom group. As indicated previously, this difference is attributable to the fact that 21 PREST students entered the ART program with an entering RGL between 6.0 and 6.7. Within the restricted sample, the entering RGLs for the classroom and PREST groups were comparable. Although the PREST restricted group had higher AFQT and WK scores than did the classroom group, the differences were not significant.

An ANOVA performed on scores obtained by the restricted samples on the NRRT pre- and posttests showed that both groups improved significantly in their general reading comprehensive skills during the instructional treatment ($F(1,74) = 82.0$, $p < .001$). However, there was no overall significant difference between the groups ($F(1,74) = 2.96$, $p > .05$) and, more importantly, no significant difference in pre- to post-gain between groups ($F(1,74) = 0.5$). These findings were verified by results of a duplicate ANOVA performed on the Gates-MacGinitie test scores obtained by the two groups. Confirmation came from an analysis of covariance (ANCOVA) performed on the post-NRRT scores using the pre-NRRT scores as a covariate. With pretest differences removed, there was no statistically

significant difference between groups on the post-NRRT scores ($F(1,72) = 1.18$, $p > .25$).[2] Also, the difference in instructional days required by the restricted groups was not significant ($t = .82$, $p > .2$).

Table 1

Measures Obtained for Restricted and Overall Samples

Measure (Mean)	Restricted Sample[a] Classroom (N=47)	Restricted Sample[a] PREST (N=47)	Overall Sample Classroom (N=75)	Overall Sample PREST (N=77)
Background Data				
Entering RGL	5.5	5.6	5.2	5.7
AFQT score	38.2	40.6	38.8	40.3
WK score	43.9	44.3	44.4	44.9
High School Graduates (%)	96.0	96.0	93.0	92.0
Immediate Effects				
NRRT score				
Pretest	17.0	17.6	16.0	17.7
Posttest	20.1	21.1	19.3	21.0
Gates-MacGinitie test score[b]				
Pretest	39.7	40.1	—	—
Posttest	42.2	43.3	—	—
Number instructional days	11.3	12.2	13.1	12.6
Prolonged Effects				
Recruit Academic Test 1 (% correct)	66	66	63	68
Recruit Academic Test 2 (% correct)	63	67	63	66
Recruit Academic Test 3 (% correct)	63	65	63	66
Recruit Academic Test 4 (% correct)	71	71	71	71

[a]Includes only those students with RGLs between 5.0 and 6.0.

[b]Scores not included for the overall samples because of the ceiling effect noted.

[2]The NRRT data were analyzed by two methods, both yielding the same conclusion. They were: (1) a 2 x 2 x 2 repeated measures ANOVA with groups and the blocking-factor test forms as between effects and the tests as repeated measures, and (2) a groups by test forms ANCOVA on the posttest scores using the estimated true pretest score as the covariate. Each of these designs has its advantages for the analysis of intact nonrandom groups (Lord, 1967; Kenney, 1975; Cronback & Furby, 1970). The estimated true pretest scores were used to reduce bias in the ANCOVA caused by error in obtained pretest scores (Reichardt, 1979; Lord, 1956). The estimated true scores were calculated by multiplying deviation scores by the test-form reliability (Kuder-Richardson 20), and then converting back to raw scores.

The ANOVA performed on recruit academic test scores obtained by restricted sample members completing all four tests revealed no overall significant differences between groups ($F(1,64) = 1.79$, $p > .15$) and no significant differential change between groups over tests ($F(3,192) = 1.74$, $p > .15$). Both groups improved significantly from Test 1 to Test 4 ($F(3.192) = 13.99$, $p < .001$), raising their mean score from 66 to 71. Thus, the prolonged benefits provided by the two approaches to ART were equal, with the two groups having equal scores and gaining by the same amount.

Finally, the attrition of the groups did not differ significantly, with 17 and 16 from the classroom and PREST groups respectively attriting before completion of recruit training. Most of the attrition was attributable to nonacademic reasons; only three recruits (one from the classroom group and two from the PREST group) were discharged because of academic failure in recruit training.

Since the two approaches were equally effective, it was not necessary to quantify any differences in instructional advantage in terms of cost savings. However, there are other aspects of PREST worth reviewing. Observations of the students using the PLATO system revealed that they were very attentive and very interested in their training and that one instructor could adequately handle 24 students. (The two military personnel at Orlando who served as the PREST instructors stated that 30 students would be a realistic maximum.) Most of the instructor time was spent in answering questions, providing feedback, or moving a student from on-line instruction to off-line materials. Although the efficacy of the off-line materials cannot be statistically assessed from available data, the work-sheets developed by RBS appeared to be quite good and Navy relevant.

Cost Effectiveness

The costs for one year, 1980, are summarized below:

Classroom		
Instructional staff	$ 72,940	(5 @ $14,588 each)
Materials	$ 2,188	
Projected costs for 1980	$ 75,128	
PREST		
Terminals	$ 23,520	(24 @ $4,900 each; allocated over 5 years)
Usage Charge	$ 76,320	($265/terminal/month)
Maintenance	$ 10,368	($36/terminal/month)
Instructors	$ 29,176	(2 @ $14,588 each)
Subtotal	$139,384	
Cost avoidance	$ 7,022	
Projected costs for 1980	$132,362	

Figures 1 and 2 chart the time-course behavior of the projected costs, in 1980 dollars, for military and civilian instructors respectively, assuming either a constant cost for

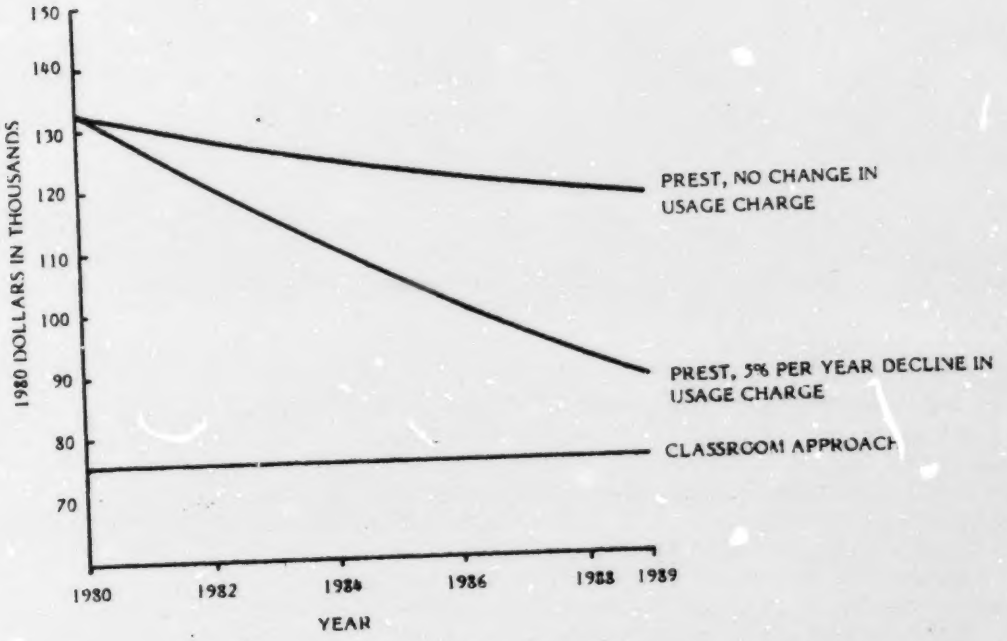

Figure 1. Cost comparisons of program delivery based on military instructors--10% per year decline in hardware costs.

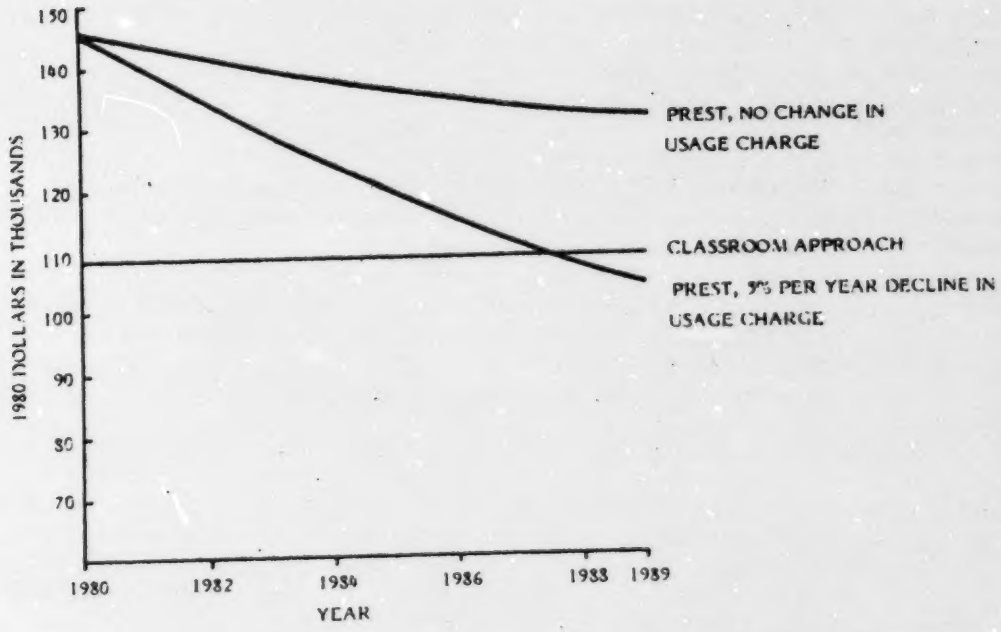

Figure 2. Cost comparisons of program delivery based on civilian instructors--10% per year decline in hardware costs.

usage charge or a 5 percent decline in this charge. With the former assumption, the costs of the alternatives, whether based on using military or civilian instructors, do not reach a break-even point during the 1980s. With the latter, the costs based on using military instructors would break even about 1990; and the costs based on using civilian instructors, in 1987.

DISCUSSION AND CONCLUSIONS

Determining whether a proposed program is cost-effective hinges on the costs of alternative programs. In this study, the classroom approach to ART was found to be more cost-effective than PREST because of the relatively low cost of military instructors. Higher instructor costs would have led to different conclusions. For example, in a recent Army study on the cost-effectiveness of PLATO compared to classroom basic skills instruction, it was concluded that PLATO was a cost-effective alternative to traditional instruction (Blevins & Phipps, 1980). However, it must be noted that this study did not include costs for the instructor managing the PLATO classroom. These costs, which covered a total of 9408 instructional hours (56 Army enlistees and 168 hours per student) were included in a $44,000 contract to a public school system to teach basic skills to Army enlistees. This amount of instruction would have cost about $12,000 at ART Orlando if military instructors were used. Although the Army study considered the PLATO system to be instructor independent, this effort considered that PREST required one instructor per 24 students. Finally, it should be noted that, if the cost-comparison had been conducted in San Diego, where salaries for civilian instructors are higher than in Orlando, the break-even point for the PREST and classroom approaches with civilian instructors would have occurred in about 1984. These examples illustrate some problems with conclusions from cost-effective studies (c.f., Kazanowski, 1968).

The usage charge for PLATO with its centralized mainframe is the main reason why PREST costs more than does the classroom approach to ART. Although the mainframe will continue to be used in cases where instruction must be managed for a large number of students or a large mix of courses is offered for a limited time, advances in computer technology are rapidly making the stand-alone systems more economically attractive than the centralized mainframe (Micheli, Morris, & Swope, 1980). In the ART environment, where the instruction is fixed throughout the year, it does not seem advantageous to pay a subscription fee continually for a limited amount of courseware and to send the same courseware repeatedly over phone lines. This problem will be partly remedied by the introduction of a PLATO system that uses microprocessors and floppy discs. This configuration still requires communication to the mainframe for test and management functions, possibly over a reserved terminal. Furthermore, the durability of the floppy discs containing the basic skills courseware must be determined before a cost analysis could be performed. This new configuration, however, will undoubtedly improve the cost-effectiveness of computer-based instruction.

Overall costs could also be decreased if the instructor staff could be decreased without a corresponding decrease in program effectiveness. In the PREST approach to ART, instructors route students to off-line materials and provide feedback regarding these materials. These off-line instructor tasks increase instructor dependence that, in turn, increases the cost of the overall configuration. Thus, if CAI were employed only in those ART modules in which the computer is instructor independent, savings due to decreased instructor costs could be realized. The extent to which this instruction could be delivered on low-cost microcomputers would lead to further cost benefits. Wisher (1980 a, b) tested an instructor-independent CAI approach to the phonics and vocabulary modules of ART. Results showed that the CAI phonics instruction was as efficient as the

classroom instruction, and that the CAI vocabulary instruction was three times more efficient than the classroom instruction. Thus, it appears that if, for example, the highly efficient vocabulary instruction were delivered on a low-cost device, the system would be highly cost-effective today. This assumes that one instructor is eliminated, and the costs of the hardware are allocated over 5 years. The technology is now available to deliver cost-effective training for some of the ART modules.

This evaluation of PREST did not test a nonnative English speaking population. Thus, it is not known how effective PREST would be for them. Since this population is an increasing concern in the Navy (Salas, Kincaid, & Ashcroft, 1980), plans are being made to develop and implement--in FY 81--a separate ART module for them. Any computer-based system being considered as a substitute for classroom instruction must be suitable for this population.

Because of the varying month-by-month throughput, savings could probably be realized by turning off some terminals during the winter months. The increase in ART entrants during the summer months would require that instruction be staggered throughout the day or that the off-line materials receive more usage. In the classroom, the student/instructor ratio fluctuates during the year. The cost for the varying throughput, however, affects the classroom and PREST configurations equally.

The off-line worksheets would be an excellent addition to the ART study skills module. Since they are Navy relevant, they would complement the current civilian-relevant classroom materials.

RECOMMENDATIONS

1. The PREST program should not be substituted for the current ART classroom approach at this time.

2. Consideration should be given to (a) replacing the vocabulary and comprehension modules of ART with a computer-based system and (b) using low-cost, stand-alone microcomputers as the delivery devices.

3. The contractor-developed worksheets should be incorporated into the ART study skills module.

4. The NRRT should be developed further as a selection device for ART.

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